Observations on the Life Cycle of *Heliconius hecale zuleika* (Hewitson) in Costa Rica

(Lepidoptera: Nymphalidae)

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The neotropical butterfly *Heliconius hecale* (Fabricius, 1775) is one of the most widespread and variable species of *Heliconius* in many regions of Central and South America. In the Pacific dry lowlands of Guanacaste Province, Costa Rica, the form *H. hecale zuleika* (Hewitson) (Fig. 1) is very abundant in pockets of moist secondary and riparian forests along rivers. In fact, densities of this butterfly approach the unusually high densities of the closely related species, *H. ethilla* Godart, reported in some regions of Trinidad (Ehrlich and Gilbert, 1973). Along with *H. ethilla*, this species, *H. melpomene* and others belong to the "silvaniform" group of *Heliconius* (Brown and Mielke, 1972; Ehrlich and Gilbert, 1973). The widespread occurrence of *H. hecale* and it's regional differentiation into distinct subspecies or races is probably the result of it's ability to thrive in a variety of different habitats, including man-made (Brown, 1972), over a wide geographic area (Brown and Mielke, 1972). Thus there occur no less than fifteen distinct subspecies in Amazonian and near "extra-Amazonian" Brazil alone (Brown and Mielke, 1972). The present paper summarizes some observations on life cycle, larval food plant, and behavior of the subspecies *zuleika* in lowland Guanacaste Province, Costa Rica, including what is apparently the first published account of its immature stages and larval host. Such information, especially food plant records, is crucial for understanding the population dynamics of *Heliconius* butterflies, since at least some populations of *H. erato* in Costa Rica are limited by the larval food plant (Benson, 1972).

MATERIALS AND METHODS

The majority of field observations on adult behavior, larval food plant, and interactions with other heliconiines were done near the town of Miramar, along the Inter-American highway in Guanacaste Province, Costa Rica. The actual study site is the "Barranca site" a patch of semi-deciduous tropical wet forest in the lowlands. Orians (1969) gives a good description of the site, and it is supplemented by Janzen (1971).

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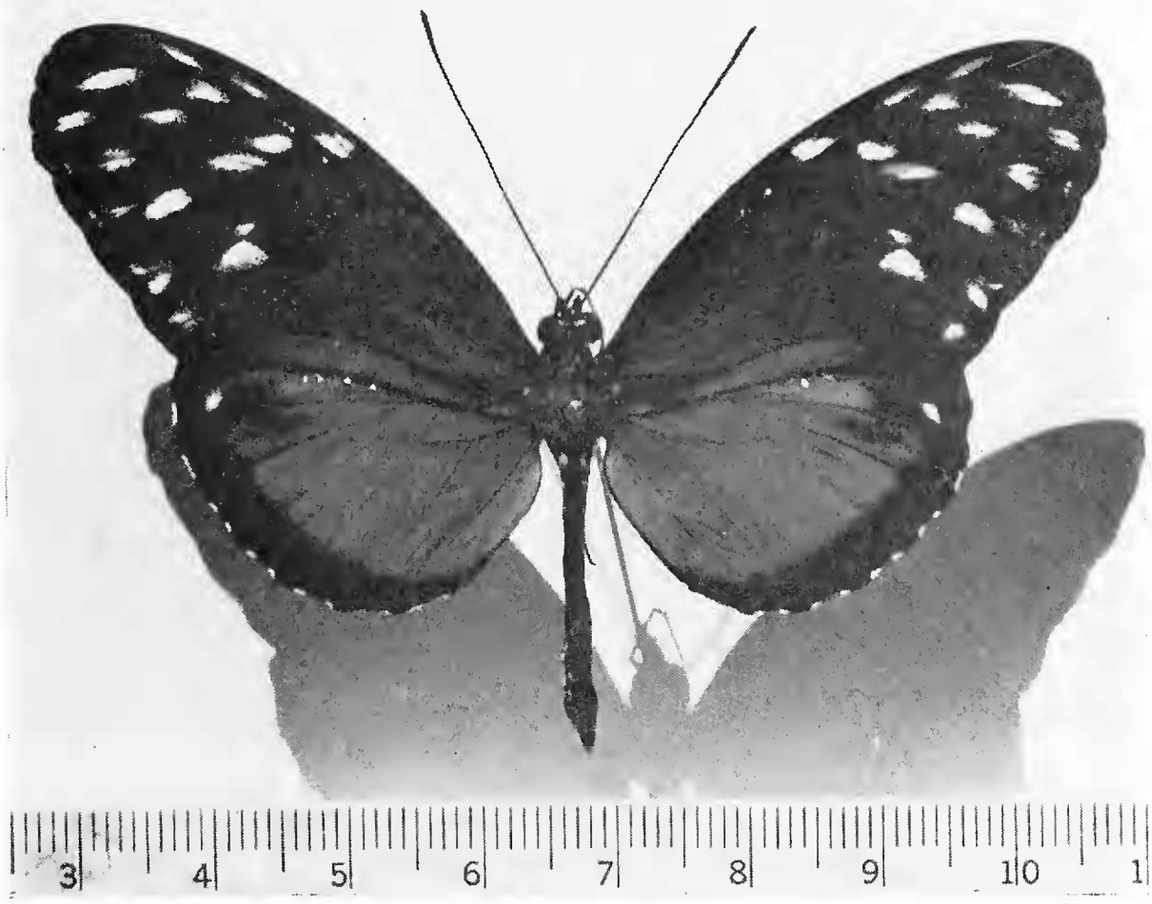

FIG. 1. Adult male *Heliconius hecale zuleika* (Hewitson), dorsal view. Scale in mm. This specimen was reared in the laboratory from the egg stage.

Activities of *H. hecale* were generally limited to the thinned-out peripheral regions of the forest.

A total of four eggs were collected July 30, 1973 and five were collected June 23, 1974. Rearing was accomplished by confining the eggs with fresh clippings of the plant in a single, large, clear-plastic bag kept tightly shut. The developmental time and other life history events of individuals confined to the plastic bag were measured from the egg stage to eclosion. But during this period the caterpillars were moved to several different localities in Costa Rica, perhaps distorting the actual developmental time of this species at the Barranca site resulting from uncontrolled temperature effects.

RESULTS

HABITAT AND FOOD PLANT.—In my experience, adults of *H. hecale zuleika* are most frequently encountered in dense, old secondary forest

FIG. 2. A habitat of *H. hecale zuleika* in lowland Guanacaste Province, Costa Rica. The larval food plant, *Passiflora vitifolia*, is found in the dense secondary forest at the Barranca site. This photograph was taken during the wet season (July 1973). Adult *H. hecale* exhibit some "promenading" around *Passiflora* vines here and visit conspicuous red flowers (inset).

(Fig. 2) and in the thinned-out understory of primary forest. The butterflies are fond of visiting the understory flowering plant *Cephaelis tomentosa* Aubl (Vahl) (Rubiaceae) in many parts of Costa Rica (Fig. 2, inset). Perhaps the prime reason that the butterflies are found here is the occurrence of the larval food plant in these places: at the Barranca site the plant used for oviposition and larval development of *H. hecale* is *Passiflora vitifolia*, and it is the same food plant used by this species at Finca Tirimbina in the Carribbean wet lowlands of Costa Rica. This plant occurs as a low, vine sprawling over other plants, both in sunny and shaded places (Fig. 3). This species of *Heliconius* is found along with several other heliconiines on *P. vitifolia* at the Barranca site, even to the extent that several species occur together on the same vine. As I have not done a thorough search for other food plants of this butterfly at the Barranca site, it is quite possible that others also occur there.

FIG. 3. *Passiflora vitifolia* (Passifloraceae), the larval food plant of *H. hecale* over much of Central and South America. Note the low position of the vine on the herbaceous canopy in secondary forest; a large, lobed, older leaf is apparent directly above the machete near the center of the photograph (June 1974).

P. vitifolia at the Barranca site occurs in small, scattered clumps, at least 50 meters apart. Over two years, I have found that the same clumps of this vine (a total of six examined in different parts of the forest) are infested with heliconians. Some of these clumps are so small that I would estimate that about 70% of the green foliage is destroyed during mid-July by heliconian caterpillars and perhaps other herbivores.

LIFE CYCLE.—The large, squarish egg (Fig. 4-A) is initially light yellow, darkening to orangish-yellow within one day. The distribution and numbers of vertical and horizontal ribs are identical to those of *H. melpomene* (Beebe, Crane, and Fleming, 1960). The egg is 1.4 mm high by 0.9 mm wide at the middle. The egg stage lasts five days.

The first instar larva is about 4.0 mm long at hatching, translucent, dirty-orange with a light tan head capsule. It is covered with many fine setae, and very similar to the larva of *H. melpomene* (see Beebe, Crane, and Fleming, 1960). The second instar (Fig. 4-B) is similar

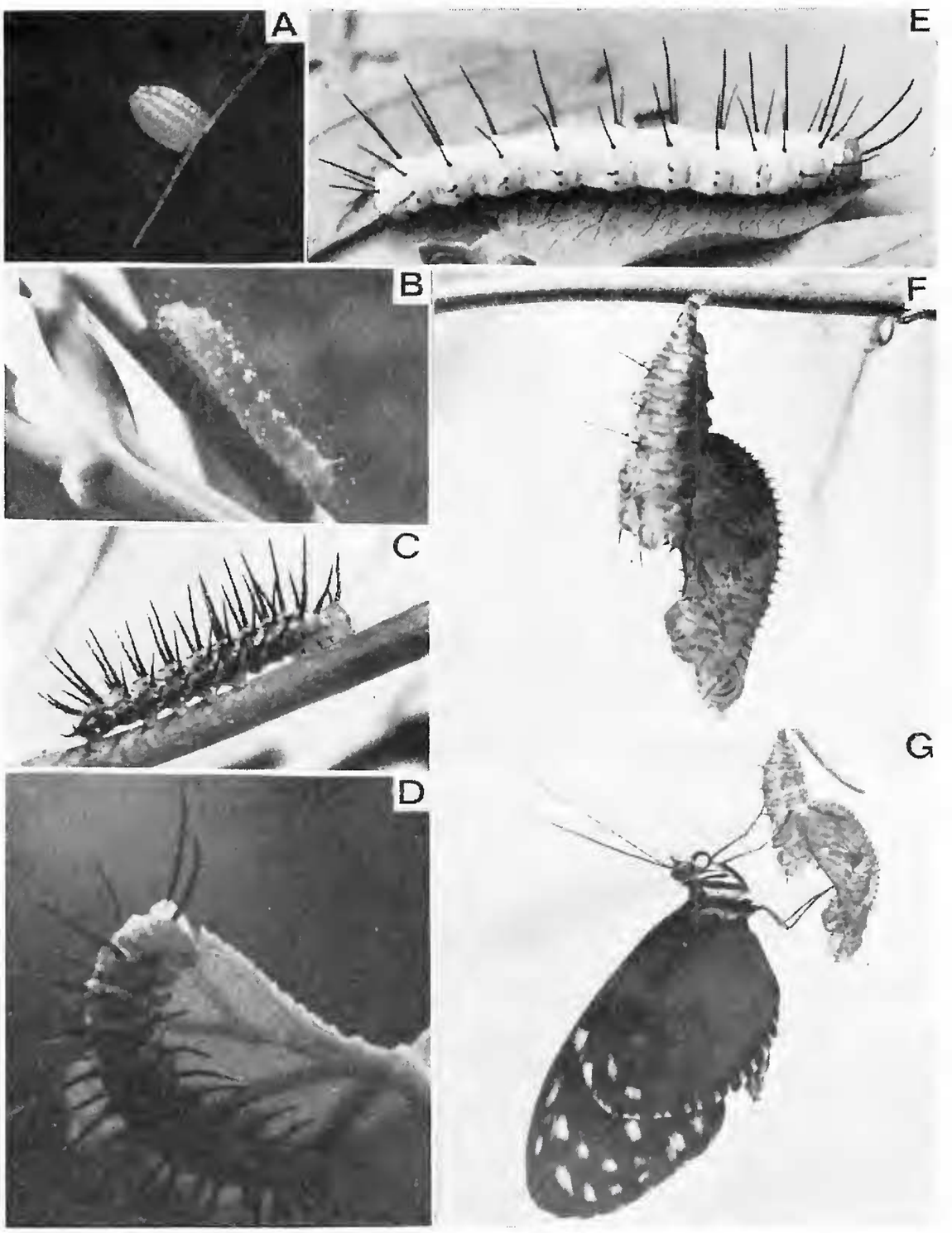

FIG. 4. The juvenile stages of *H. hecale zuleika*. A. egg; B. second instar caterpillar; C. third instar; D. fourth instar; E. fifth instar; F. pupa; G. eclosion. Sizes are given in the text.

to the first, but the head capsule is more orangish and margined posteriorly lightly in black. The prothoracic plate is brown and all scoli and legs are black. The distribution of scoli is set in this instar: the rows of dorsal, lateral, supralateral, and sublateral scoli are all apparent (see the excellent diagram for scoli distribution of *Heliconius* in Beebe,

Crane, and Fleming, 1960). The first instar lasts three days and the second instar lasts four days.

The third instar (Fig. 4-C) is very similar to the fourth instar (Fig. 4-D) but lighter in the orange color of the body. The head capsule is light orange and the trunk region is light bluish-white above and orange below. The head scolus is black and about 1.8 mm long, curved strongly to the posterior end of the body. The anal plate is light orange and all scoli are black and bear spinules. The third instar reaches a length of 16 mm in four days. The general appearance is very similar to that of *H. melpomene*. The whitish regions of the body become more pronounced in the fourth instar (Fig. 4-D) and the recurved head scoli are now about two mm long. All scoli are black and longer in this instar (Fig. 4-D). The prolegs remain orange as in the previous instars. This instar attains a length of about 27 mm in four days.

The fifth instar (Fig. 4-E) is strikingly different in appearance from the previous stages. The body is now chalky-white and the head capsule glossy light orange. The recurved head scolus is now almost 6 mm long and all scoli are black. All spiracles are black and a lateral black dot occurs at the posterior edge (fold) of each segment; a second, less distinct black spot occurs just above the sublateral scolus. The fifth instar attains a length of about 38 mm in six days, and it is strikingly similar in appearance to the fifth instar of *H. cydno* (see Young, 1973[1]).

The pupa (Fig. 4-F) fits into the general description of "Group C" *Heliconius* in Beebe, Crane, and Fleming (1960); it is very similar to the pupae of *H. melpomene* and *H. numata*. The pupae of this group are characterized by (1) spines on the thorax, abdomen, and antennae, (2) subdorsal flanges on the abdomen, and (3) three to five pairs of gold-colored spots on the thorax and abdomen. In *H. hecale* there are three pairs of gold spots on the abdomen. The length of the pupa is 33 to 34 mm and the general coloration is mottled light and dark brown. The spines on the ventral side of the abdomen are very long and black. The subdorsal flanges are very well developed on the first two abdominal segments. The first five abdominal segments bear alternating long and short spines, a single spine on the first segment, pairs of spines on succeeding segments. The head region is coarsely sculptured with a pair of distinct anterad projections. Along the dorsal line of each wing pad there is a series of short, curved black "hooks" that continue to the prothoracic midline and to the head (ventrally). The

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[1] The fifth instar was incorrectly labelled in that publication as the third instar (switch captions for Figs. 2 B–C, p. 243).

cremaster silk is orange. When touched, the pupa is capable of violent twitching movements from side to side. It is not known if the pupa is capable of sound or odor production although Alexander (1961) mentions that the pupa of the closely related *H. melopmene* does both. The pupal period lasts 10 to 14 days, falling within the upper limit of range reported for Group C pupae (9–10 days). Eclosion (Fig. 4-G) is rapid and the first meconium is brownish; Alexander (1961b) reports that the first meconium of the related species *H. melpomene* ranges from brown to chestnut.

BEHAVIOR OF ADULT BUTTERFLIES.—Oviposition behavior usually entails the female flying very low through an area where the larval food plant is found. A female may fly back and forth through the area many times before actually landing and depositing an egg. I have noticed similar prolonged pre-oviposition flight habits in *Philaethria dido* and other unidentified *Heliconius*. Eventually an egg is laid on either a very young (unfolding) leaflet or tendril; in a total of four oviposition acts observed, the egg was never laid on older leaves and other structures.

Adults are usually encountered singly during the morning and I did not determine if nocturnal communal roosting, known for some species of *Heliconius* (see summary in Benson, 1971), occurs in *H. hecale*. Adults probably visit a variety of flowers, but are known to be attracted to the bright red flowers of *Cephaelis tomentosa* (Fig. 2-inset). At least two closely related species, *H. ethilla* and *H. melpomene* show strong preferences for red flowers in Brazil (Brown and Mielke, 1972). Collected adults have been noted with at least two types (colors) of pollen, also suggesting lack of food plant specificity.

BEHAVIOR OF CATERPILLARS.—As with species closely related to this butterfly (see Alexander, 1961a; Brown and Mielke, 1972), the caterpillars of *H. hecale* are solitary, a condition very likely the result of single oviposition. It often happens that caterpillars in different instars will be found on the same vine of *P. vitifolia*, but generally highly scattered with no apparent interaction. It is likely that a single vine is exploited repeatedly throughout the year for egg-laying by this species and several other *Heliconius*. The youngest caterpillars are invariably found on terminal and subterminal leaflets and even tendrils. Older caterpillars also feed on subterminal leaflets (Fig. 4-D), although fifth instars are generally found on older leaves. Caterpillars generally feed from undersides of leaves, although I have seen fifth instar caterpillars on the dorsal side of drooping older leaves of the food plant. Such individuals are extremely conspicuous. Caterpillars often

share adjacent leaflets and leaves with other heliconians on *P. vitifolia*: at Finca Tirimbina, *H. hecale* co-occurs with at least *Philaethria dido* (Young, 1974), while at the Barranca site it co-occurs with *H. cydno*, *H. isemenius*, and *Dione*.

DISCUSSION

As one of the "silvaniform" species of *Heliconius*, *H. hecale* displays close morphological resemblance in the early stages to other members of this group, such as *H. ethilla* (formerly *numata*) and *H. melpomene*. The life cycle characteristics described for *H. hecale* agree with the general features of *Heliconius* biology as summarized by Brown and Holzinger (1973) : eggs are usually laid on young ("growing meristem") structures, and adults collect pollen. The egg is large and yellowish, and the head capsule does not bear stripes. The pupa usually hangs vertically.

The fifth instar bears a striking resemblance to *H. cydno* and it is interesting to speculate that the two species participate in a Müllerian mimicry complex as caterpillars, especially since both species occur on the same food plant and in the same habitats in Costa Rica. Mimicry has been suggested by Brown (1972) with respect to other *Heliconius* in Brazil.

Brown and Mielke (1972) comment that *H. hecale* is very widespread in Brazil, not only geographically but also in terms of habitats; the apparently high degree of distinct sub-speciation in this species in Brazil is believed to be the result of phenotypic flexibility perhaps coupled with restricted gene flow. In Central and South America, the widespread occurrence of *H. hecale*, clearly far more extensive than many other species of *Heliconius*, must be due in part to the widespread occurrence of *Passiflora vitifolia* and other food plants. Keith S. Brown, Jr. (pers. comm.) states that *P. vitifolia* is used by *H. hecale* throughout Central America and Colombia and as far as Ecuador. Young (1974) discussed *P. vitifolia* as a larval food plant of *Philaethria dido* in northeastern lowland Costa Rica. At least three genera of heliconians and a large number of species (of *Heliconius*) use *P. vitifolia*, probably for the following reasons: (1) the widespread geographical distribution of the plant makes it an attractive resource for heliconians, (2) the plant species occupies several different habitats within a geographic (regional) zone, and (3) the plant is unusually low in those defense systems that normally deter heliconians and perhaps other herbivorous insects. Whatever the precise reasons for it's abundance over much of tropical America, this and perhaps other species of

Passiflora are easily penetrated (in the evolutionary or ultimate sense of Ehrlich and Raven, 1964) by local complexes of heliconians.

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RECENT LITERATURE

BIOLOGY, ECOLOGY, AND HOST SPECIFICITY OF MICROLEPIDOPTERA ASSOCIATED WITH QUERCUS AGRIFOLIA (FAGACEAE). Paul A. Opler. University of California Publications in Entomology, Vol. 75, 83 pp., 38 figs., 7 plates, 8 tables. $4.25.

Taxonomically, the microlepidoptera remain one of the most poorly known groups of insects, as demonstrated by the fact that 57% of the species treated in this study were undescribed at the time the research was conducted. Nevertheless, this work is primarily ecological, containing no descriptions of new species, and no keys. The text contains a wealth of documentary data concerning interrelationships between the moths, their host, and important climatic and distributional variables. This descriptive information is balanced with extensive discussion of life cycle adaptations, host specificity, biogeographic distribution, and evolution. The diversity of biological adaptations of the moths to avoid unfavorable seasons or to reduce interspecific competition reveal these small insects, usually ignored by all but specialized taxonomists, to be highly interesting and significant subjects for ecological analysis. The evolution of the moths is related to evolution of their host, emphasizing the fossil record of the oak and the host relationships and present distribution of the insects. The antiquity of the leafmining habit is documented by Miocene fossil impressions which are practically indistinguishable from mines of extant moths. The text is accompanied by useful tables and figures comparing the chronology of development of different species, host relationships, and details of geographic distribution. Plates include photographs of examples of larval mines and shelters and eggs in typical oviposition sites.—*Editor.*

REVISION OF THE MILLIPEDE FAMILY ANDROGNATHIDAE IN THE NEARCTIC REGION (DIPLOPODA: PLATYDESMIDA). M. R. Gardiner. Memoirs of the Pacific Coast Entomological Society, Vol. 5, 61 pp., 46 text figures. (Available from Pacific Coast Entomological Society, c/o California Academy of Sciences, Golden Gate Park, San Francisco, California 94118. $3.00).

Taxonomic study of the five nearctic genera of platydesmid millipeds, including one new species from northern California.